(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 June 2004 (03.06.2004)

PCT

(10) International Publication Number
WO 2004/047010 A1

(51) International Patent Classification[7]: G06K 9/36, 9/40

(21) International Application Number:
PCT/US2003/036213

(22) International Filing Date:
15 November 2003 (15.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/426,830 15 November 2002 (15.11.2002) US

(71) Applicant *(for all designated States except US)*: **THE ARIZONA BOARD OF REGENTS on behalf of THE UNIVERSITY OF ARIZONA** [US/US]; 888 N. Euclid Avenue, Room 204, P.O. Box 210158, Tucson, AZ 85721-0158 (US).

(72) Inventors; and

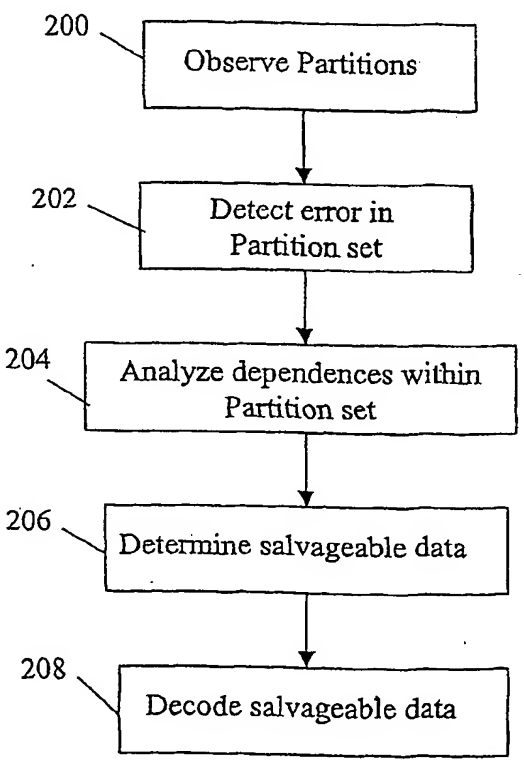
(75) Inventors/Applicants *(for US only)*: **MARCELLIN, Michael, W.** [US/US]; 6535 N. Camino de Michael, Tucson, AZ 85718 (US). **BILGIN, Ali** [TR/US]; 1300 E. Ft. Lowell Rd., Apt. M-215, Tucson, AZ 85719 (US). **WU, Zhenyu** [CN/US]; 951 E. 10th Street, Apt. 22, Tucson, AZ 85719 (US).

(74) Agent: **MILCZAREK-DESAI, Gavin, J.**; Quarles & Brady Streich Lang, One South Church Avenue, Suite 1700, Tucson, AZ 85701-1621 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: METHODS FOR DECODING CORRUPT JPEG2000 CODESTREAMS



(57) Abstract: The present invention provides a method for decoding corrupt codestreams for encoded digital imagery and video and, in particular, JPEG2000 codestreams with improved error resilience properties. The decoding techniques apply to a class of coding algorithms in which the data from underlying images are partitioned, typically to allow decoding of different spatial sections of the image, and the rules governing the dependencies within and perhaps between partitioned sets are known. Corrupt codestreams are decoded with improved image quality by observing the partitions imposed by the underlying algorithm (200), detecting an error in a partition set (202), analyzing the dependencies within and perhaps between the partitions (204), determining what sections of encoded data that follow the error in the partition set can be salvaged (206), and decoding those sections (208). Even though there might be errors in a particular partition, portions of that partition might still be completely or partially decodable, depending on certain modes or "switches" used during the creation of the codestream.

WO 2004/047010 A1

(84) **Designated States** *(regional)*: ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/36213

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : G06K 9/36, 9/40
US CL : 382/232,233,235,251,252,274,275
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 382/232,233,235,251,252,274,275

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MARCELLIN et al. An Overview of JPEG-2000. Data Compression Conference 2000, pages 1-19, especially pages 6-14.	1-15, 17, 19, 24-29
Y	SANCHEZ et al. Robust Transmission of JPEG2000 Images Over Noisy Channels. IEEE June 2002, pages 451-456, especially pages 451-453.	1-15, 17, 19, 24-29
A	CHIANG et al. Efficient Pass-Parallel Architecture for EBCOT in JPEG2000. IEEE May 2002, pages 773-776.	1-29
A	MAN et al. An Error Resilient Coding Technique for JPEG2000. IEEE 2000, pages 364-367.	1-29
A	TAUBMAN et al. JPEG2000: Standard for Interactive Imaging. IEEE August 2002, pages 1336-1357.	1-29
A	LEE et al. Bit-Plane Error Recovery Via Cross Subband for Image Transmission in JPEG2000. IEEE August 2002, pages 149-152.	1-29
A	PAVLIDIS et al. JPEG2000 Over Noisy Communication Channels the Cost Analysis Aspect. IEEE June 2002, pages 561-564.	1-29
A	WU et al. Unequal Error Protection for Transmission of JPEG2000 Codestreams Over Noisy Channels. IEEE September 2002, pages 213-216.	1-29

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
24 March 2004 (24.03.2004)

Date of mailing of the international search report
14 APR 2004

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
Facsimile No. (703)305-3230

Authorized officer
for Michelle R. Eason
Virginia Kibler

Telephone No. (703) 306-4072

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

PCT/US03/[illegible]13

Continuation of B. FIELDS SEARCHED Item 3:
IEEE, Google
search terms: codeblock, corrupt, JPEG2000